by Dr. Struve from the occultations of 1884; and in order to compare the curves, I have supposed this point to be the zero for Dr. Hayn's measurements, and that the "mean level" which he adopts as a standard is at $15' \, 32''\cdot5$ in the diagram.

The occultation curve is compounded of the curves representing the groups of results for 1884 and 1888 and some smaller groups. If the declination of the Moon's centre in respect of any group is corrected, the curve for that group will be turned about the east or west point of the limb; the east and west points for the eclipse of 1884 are at position-angles 114° and 294°, and those for the eclipse of 1888 are at 73° and 253°.

Uplands, Cobham, Surrey:
1908 *June* 7.

The Lunar Bright Rays. By H. G. Tomkins.

It is with some hesitation that I venture to add to the numerous theories which have at one time or another been put forward regarding the lunar bright rays, and my excuse must be the close analogy which exists between them and certain terrestrial phenomena, and the ease with which it can be applied to the Moon.

The present explanation is based, firstly, on the assumption that the configuration of the ray systems may be due to a cause separate from their albedo; secondly, that similar configurations appear to exist on the Earth; and thirdly, that a terrestrial analogy to the white material of the rays is also available.

Taking the albedo first, I am led to think that this can be explained on the supposition that the white material consists of the soluble saltsof sodium and other minerals contained in the lunar crust. In the case of the Earth, these salts are brought to the surface by evaporation in a great many parts of the globe. The salts originally exist below the surface, either in the shape of beds of solid salt or salt-impregnated strata; and when they come into contact with the subsoil water, they rise to the surface in solution, and, on the drying up of the water, are left as a white efflorescence. In arid parts such as are found in North India and Persia, the efflorescences are very abundant, and a map of the tracts in the countries named exhibits a distinct tendency towards a radial formation, one of the strips extending about 800 miles towards Bengal from the Salt Range. In Germany also, though, owing to a temperate climate, efflorescences do not occur on a large scale, the brine springs, indicating the presence of the salts, have a distinctly radial configuration. In these cases the white material and the radial formations appear to occur together. This, however, need not always happen, and, as a matter of fact, in many countries the efflorescences do not seem to show any radial tendency, and, on the other hand, radial configurations sometimes appear without efflorescences. This is easily explained when the

origin of the radial configurations on the Earth is considered. They are referred to by several geologists of note, and in particular by Judd in his work on volcanoes, in which he quotes the case of the Lipari Islands, and states that a similar arrangement can be traced in many volcanic regions, especially those in which a great central volcano has existed. They are due to intrusion of liquid matter from below, which, by pushing up a centre of volcanic activity, causes the formation of radial fissures, and upheavals of strata round it. They are not always visible, however, on the surface.

Consequently, if such a system of upheavals occurred in the neighbourhood of saline deposits, the saline strata would be pushed upwards along with other strata, and this would bring them within the reach of evaporation at those places, and result in efflorescences on the surface which would follow the direction of the upheavals, and a radial formation would thus occur. Judd also mentions the presence of saline springs in some cases.

On the Moon, all the conditions of such a state of affairs exist. Careful observation very quickly shows that the ray systems differ greatly in configuration from one another—in fact, their prominent central formations and their albedo are about the only real points of resemblance, and this leads to the conclusion that their albedo may differ in origin from their configuration. As regards the latter, the central formation, the radial configuration of the streamers, the complex forms round Copernicus, and the differences of the systems between themselves, all point to an origin similar to that of volcanic centres on the Earth. Experiments made by Nasmyth and Carpenter and many others also testify to the probability of radial formations accompanying central upheavals or pressure.

Sir George Darwin has demonstrated the probability of the Moon having once been a part of the Earth, and it is reasonable, therefore, to assume that it has a similar constitution; in which case the existence of the salts of sodium and other minerals would be expected on the Moon—more especially sodium, which spectroscopic evidence shows to be present on the Sun and other heavenly bodies. Water does not exist in its free state on the lunar surface, but it is admitted that there is no reason why water should not have existed in the soil; and with the lunar climate, there would therefore have been cause for strong evaporation at some time, even if it does not still continue.

Consequently, any soluble salts in the lunar crust would come to the surface in the shape of efflorescences, and, owing to the absence of clouds or rain which might temporarily operate to reverse the process of evaporation, as on the Earth, the salts would rise more or less continuously, would remain permanently on the surface, and would follow the configurations of the ground, as already explained. If on the Earth water and rain were to disappear from the surface, a similar state of things would inevitably ensue; and in addition to the countries now affected, the areas occupied by the ocean would also have to be taken into account, with the enormous quantities of salts at present in solution.

The only objection of importance to the above explanation is the observed late appearance of the lunar rays at sunrise, and their early disappearance at sunset, which has been regarded by some as indicating physical change of the material of the rays. Such change would not, of course, occur with the salts. The facts, however, that the rays can easily be seen during a total eclipse of the Moon as well as on the dark part of the young Moon, that there are some exceptions to the phenomena, and that, if the site of a ray is watched, sunrise can be seen to extend to it exactly in the same manner as to other formations, are evidence against any physical change, and indicate that their invisibility is probably merely due to the fact that there is little or nothing except their albedo to notify their presence to the eye, and that they are there all the time, and only *seem* to appear when the illumination is sufficient to produce a contrast between the white material of which they are composed and the surrounding country.

I may also add that experiments made by me on this assumption entirely agree with Professor W. H. Pickering's observations that the appearance and disappearance of the rays take place when the solar altitude is from 5 to 10 degrees.

For purposes of the explanation of the rays, therefore, these phenomena can be put down to variations of illumination, and neglected.

Canterbury:
1908 *June* 3.

Observations of Daniel's Comet (d 1907) at the Radcliffe Observatory, Oxford.

(*Communicated by the Radcliffe Observer.*)

The following observations were made with the 10-inch Barclay Equatorial, using the Grubb wire-micrometer with power 200.

Observer—Mr. W. H. Robinson.

Date.	G.M.T.	Local Sidereal Time.	Comet *minus* Star, (Corrected for Refraction only). R.A.	Comet *minus* Star, (Corrected for Refraction only). N.P.D.	No. of Comps.	Apparent R.A. of Comet.	Corrections for Parallax in R.A. p.	Log. (p×Δ).	Apparent N.P.D. of Comet.	Corrections for Parallax in N.P.D. q.	Log. (q×Δ).	Ref.
1907.	h m s	h m s	m s	′ ″		h m s	s		° ′ ″	″		
July 30	14 40 54	23 6 9	−0 23·64	...	12	4 15 13·88	−0·48	9·5658	...	...	...	(a)
30	14 45 31	23 10 48	...	−1 32·2	15	...	...	...	74 15 45·4	−8·2	0·7964	(b)
Aug. 11	15 6 44	0 19 22	+1 46·77	+1 10·6	4	6 8 1·20	−0·48	9·5798	72 37 17·1	−8·1	0·8110	(c)
13	15 49 58	1 10 37	−2 34·35	...	2	6 26 19·65	−0·46	9·5721	...	...	...	(d)
13	15 55 2	1 15 42	...	+0 3·2	2	...	...	...	72 42 12·2	−7·6	0·7931	(e)
13	16 3 55	1 24 36	−4 2·97	−1 17·3	1	6 26 24·67	−0·45	9·5661	72 42 12·7	−7·5	0·7889	(f)
18	15 38 57	1 19 16	+0 34·79	−0 25·1	8	7 9 6·57	−0·43	9·5785	73 15 14·9	−7·4	0·8134	(g)
20	15 57 13	1 45 29	+1 15·29	...	5	7 25 24·06	−0·41	9·5762	...	...	...	(h)
20	15 58 35	1 46 51	...	−3 8·8	3	...	...	...	73 35 32·5	−7·1	0·8093	(i)
26	15 48 44	2 0 37	−5 50·15	−3 3·5	3	8 10 54·23	−0·37	9·5750	74 53 6·1	−6·6	0·8255	(j)
Sept. 8	16 16 24	3 19 38	+5 56·09	−3 33·4	1	9 37 25·18	−0·29	9·5672	78 40 40·6	−5·3	0·8335	(k)
8	16 41 24	3 44 42	+3 45·77	−7 4·4	4	9 37 32·08	−0·29	9·5683	78 40 59·2	−5·2	0·8258	(l)
11	16 41 14	3 56 21	−7 38·65	+7 44·9	2	9 55 19·48	−0·27	9·5671	79 40 32·0	−5·0	0·8293	(m)
11	16 47 46	4 2 54	−3 16·37	+1 35·7	1	9 55 20·33	−0·27	9·5671	79 40 39·8	−5·0	0·8276	(n)